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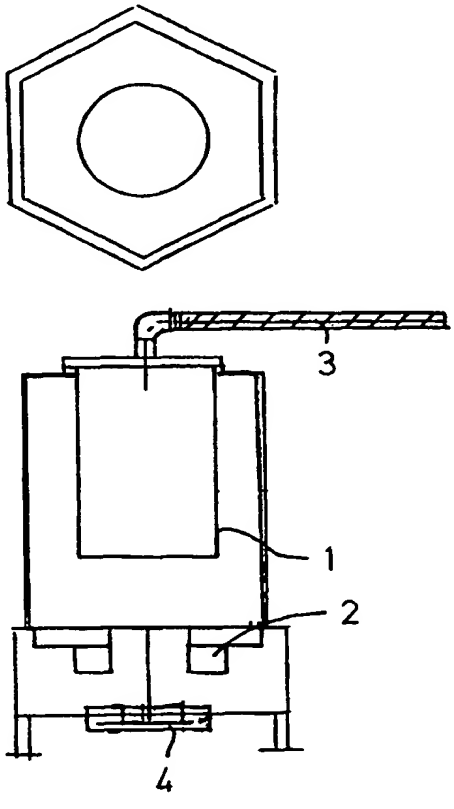
(54) Title: METHOD AND MEANS FOR DRYING

(57) Abstract

The present invention is for a method and means for drying under vacuum with heating by means of microwaves. According to the invention the drying is by a combination of heating with microwaves and vacuum inside a microwave transparent receptacle or the like. The means comprises a processing chamber (1) which through a tube (3) is connected with a condensate collector and vacuum pump. A microwave generator is mounted in the space (2) below the processing chamber.



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Method and means for drying.

The present invention is for method and means for drying under vacuum with heating by microwaves.

Many different materials and goods, primarily of organic materials, which shall or ought to be dried in connection with manufacture and/or use can not withstand exposure to high temperatures. In spite of this there is often a need for rapid drying without temperature decrease, in most case also with a limited increase of the temperature within the range that the material will stand.

According to the invention the drying is performed by a combination of microwave heating and vacuum in a microwave transparent container or corresponding device. Moist is vaporised and exhausted at low temperatures, while the microwaves keep up the temperature of the material which is being treated so that it will not be cooled off during the process. Moist is here used to mean not only water but also other substances that may be vaporised, for example some alcohols. The container may be tubes or vacuum bowls and positioned in cavities where microwaves are supplied in known manner.

The receptacles may e.g. be tubes which are mounted between the gables of the microwave applicator or cavity, the cavity may hold one or several tubes. The material which is to be treated is put into the tubes, one tube at a time being "charged". The tubes may also have lock-chambers at their ends. A tried out pattern of aluminium tape or the like material may be applied to the inside or the outside of the receptacles and function as directing antennas for the microwaves and distribute them in a desired way within the receptacle. This makes many different applications of the method possible.

The receptacles may be fixedly or movably mounted relative to the microwave applicator and may also be equipped with conveyor for loading and unloading of goods.

The invention will below be described more in detail with reference to the embodiments which are shown in the enclosed drawings.

Figure 1 shows a cross-section of a means having one processing chamber.

Figure 2 shows a means with a different positioning of the processing chamber.

Figures 3 shows a means having three processing chambers.

Figure 4 shows a means with several process chambers.

Figure 5 shows a cross section of the means of figure 4.

Figure 6 shows a means having movably arranged processing chambers.

Figure 7 shows a side view of the means of figure 6.

Figure 8 shows a means having locks for the goods.

Figure 9 shows the means of figure 8 in cross section.

Figures 10 and 11 show a continuously operating means according to the invention.

The means shown in figure 1 comprises a processing chamber 1 which by a tube 3 is connected to a condensate collector and a vacuum pump. A microwave generator is arranged in the space 2 below the processing chamber and is cooled by a fan 4. A preferably cylindrical processing chamber 1 may also be positioned with horizontal axis as shown in figure 2. In the processing chamber there is a an inner chamber 6 which is rotatable and then is driven by a motor which is placed in the space 5 underneath the processing chamber. Suitably also the vacuum equipment and the microwave generator are positioned in the lower space 5.

The means shown in figure 3 has three processing chambers 8, 9, 10 arranged horizontally side by side. Microwave generators 11, 12 are positioned on top of the outer enclosure which delimits the cavity or microwave applicator and surrounds the processing chambers while the condensate collector 7 and the vacuum equipment are positioned under the outer enclosure in the common stand.

Figures 4 and 5 show a means having eight vertically positioned cylindrical processing chambers 8, 9. In the middle there is a common cylindrical space through which the

vacuum connections are made and the outer walls of which carry the processing chambers directly or by brack ts. The middle cylinder 13 may be rotated and the processing chambers then follow along which may give the desired equalisation of the microwave energy which is supplied.

The means shown in figures 6 and 7 has four horizontally positioned cylindrical processing chambers 14, 15, 16, 17 which have a common, central mounting. By this the processing chambers may be rotated or given a to- and fro motion around a middle shaft which in this part coincides with the evacuation tube 3 through which moist which has been removed is directed to the collecting container 7. Microwave generators are positioned at the outside of a common outer housing of the processing chambers.

A further embodiment of the invention is shown in the figures 8 and 9. The processing chamber 1 is designed as an horizontal cylinder which is closed by gables 19, 20. In connection with these there are vacuum locks 25, 26 through which goods 27 may be supplied and continuously removed from the processing chamber which preferably has a built-in goods conveyor, without changing the pressure inside the chamber. Also in this case microwave generators 21, 22 are arranged on the outside of the housing which surrounds the processing chamber.

A further embodiment of the invention is shown in figures 10 and 11. A continuous conveyor 28 with scrapers 29 moves in a space within the processing chamber 1 which is delimited by an upper wall 33 and a lower wall 32. Goods is supplied through a supply tube 30 and follows with the conveyor along the separating walls 33 and 32 whereupon it is removed through the tube 31. Vacuum locks are arranged at the tubes 30 and 31 and microwave generators are suitably arranged outside the common outer housing.

In all of these cases the processing chambers are made from microwave transparent material, for example polyethylene. A patter of aluminium strips or other microwave reflecting material may be applied to the inner or outer walls of the processing chambers in order to control the distribution of the microwave energy in the processing chambers.

CLAIMS.

1. Method for drying characterized therein that the drying is performed under vacuum and simultaneous supply of microwave energy so that there is no decrease of the temperature..

2. Means for simultaneous drying under vacuum and supplying of microwave energy characterized therein that the drying is performed having the goods inside a microwave transparent container..

3. Means according to any of the preceding claims 1 characterized therein that several receptacles are placed in the same applicator.

4. Means according to any of the preceding claims characterized therein that the receptacles are moving during the drying.

5. Means according to any of the preceding claims characterized therein that the receptacles have a pattern of a metallic material on their inside or outside for distributing and spreading microwaves.

6. Anything that explicitly or implicitly is apparent from the description, claims or drawings.

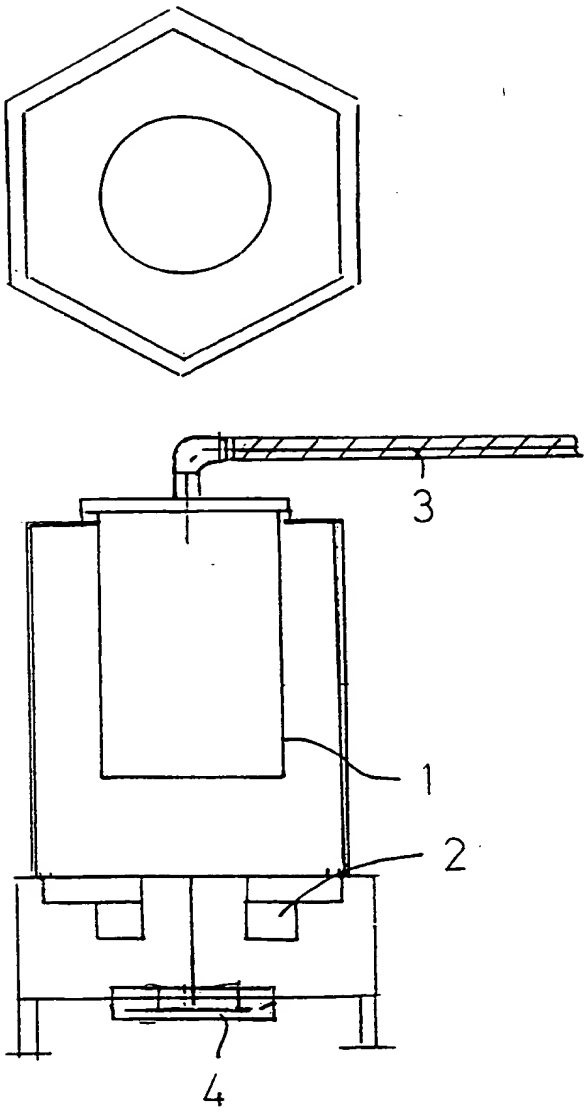

Fig 1

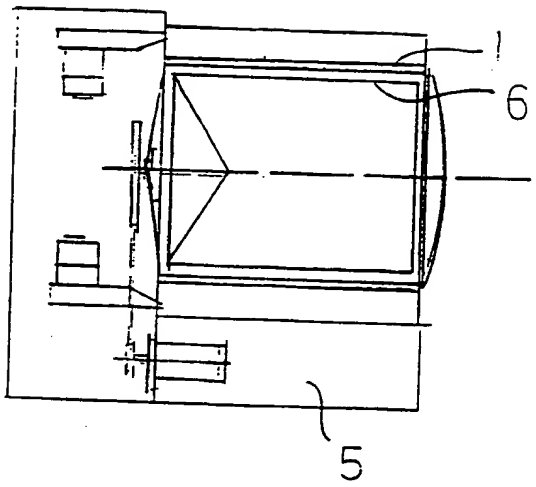

Fig 2

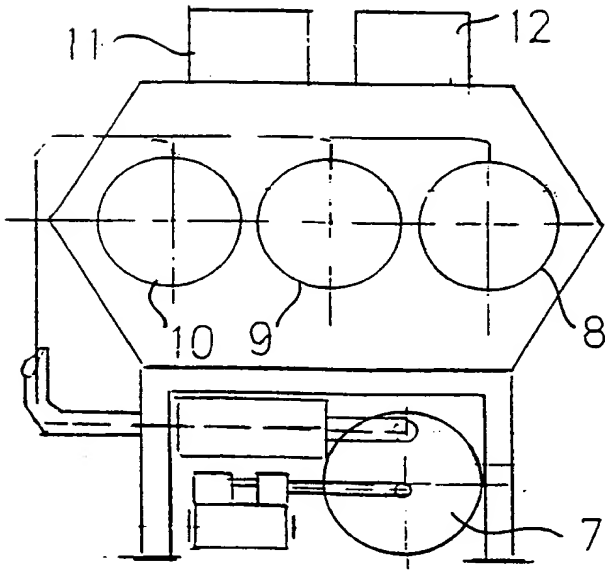

Fig 3

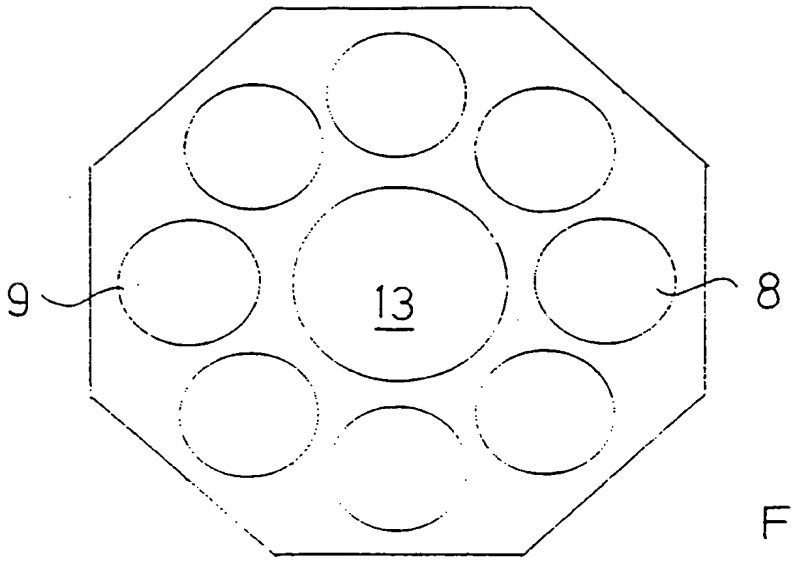

Fig 5

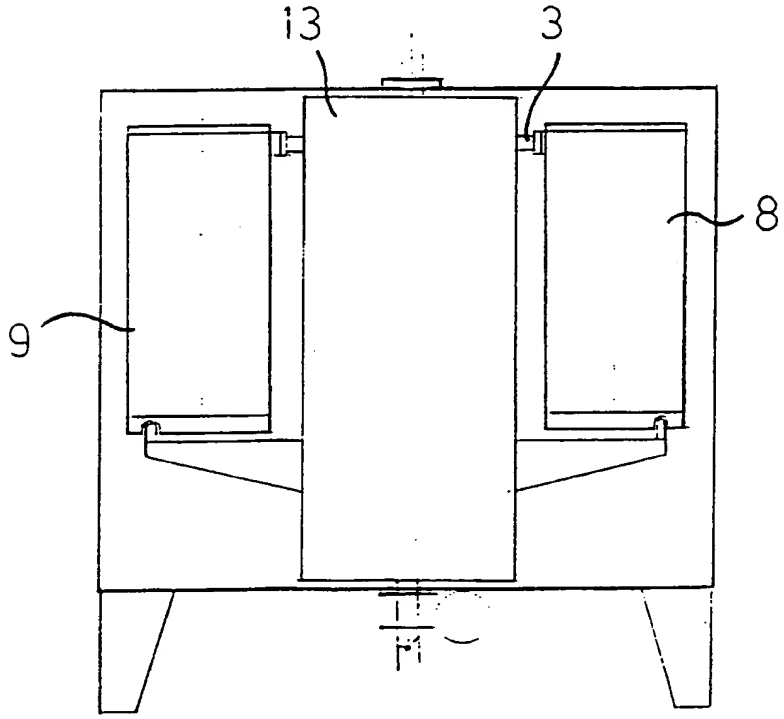

Fig 4

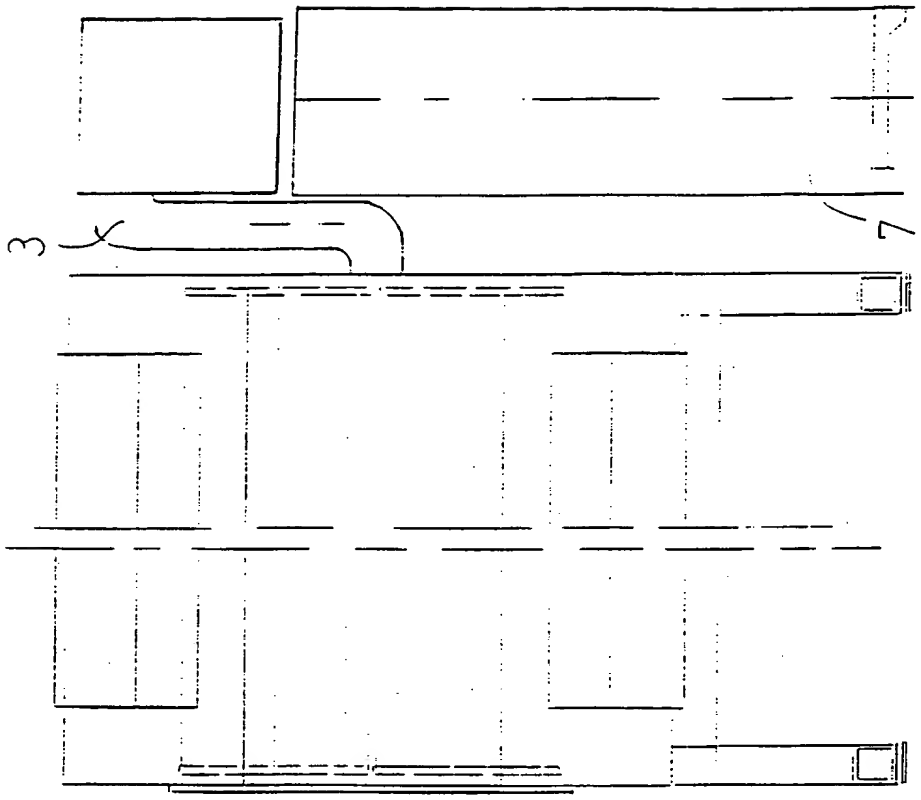

Fig 7

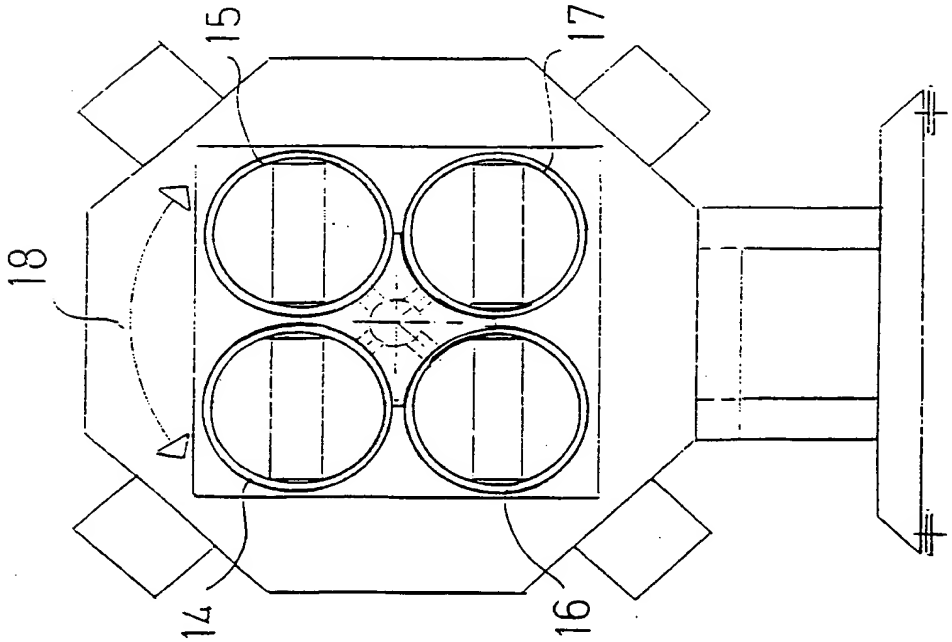

Fig 6

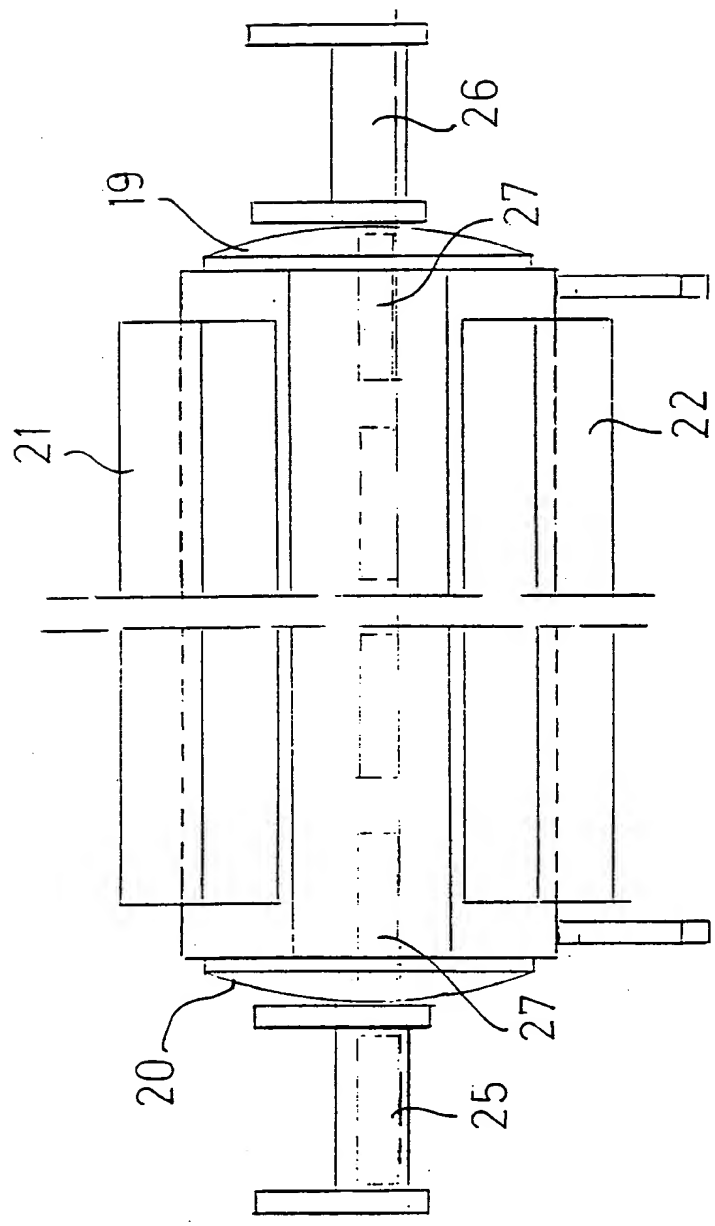

Fig 8

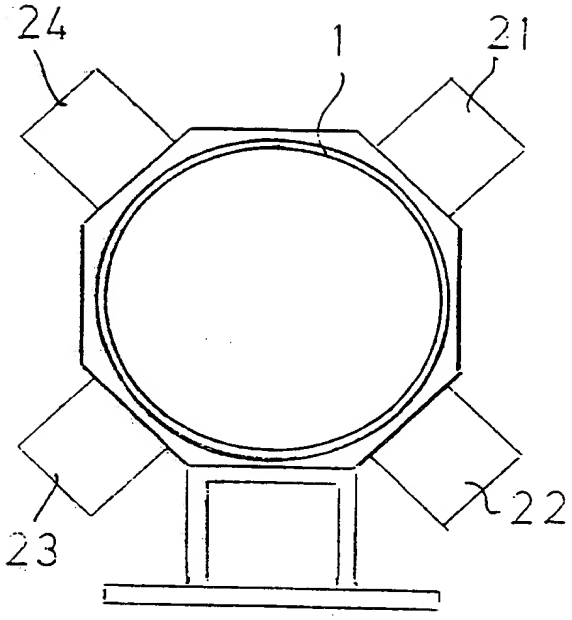

Fig 9

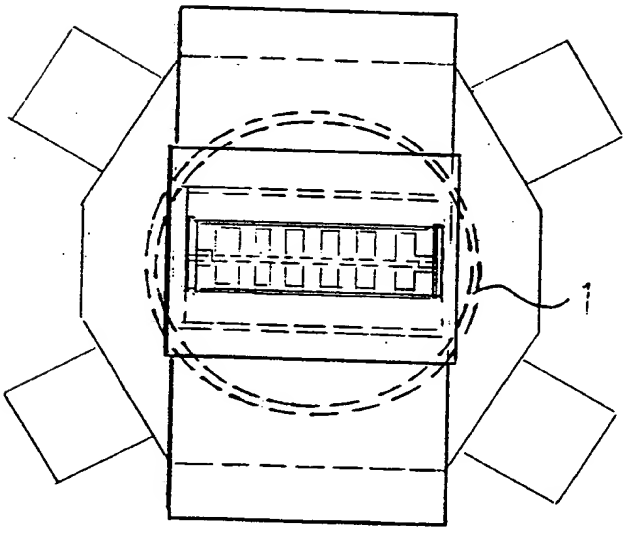

Fig 11

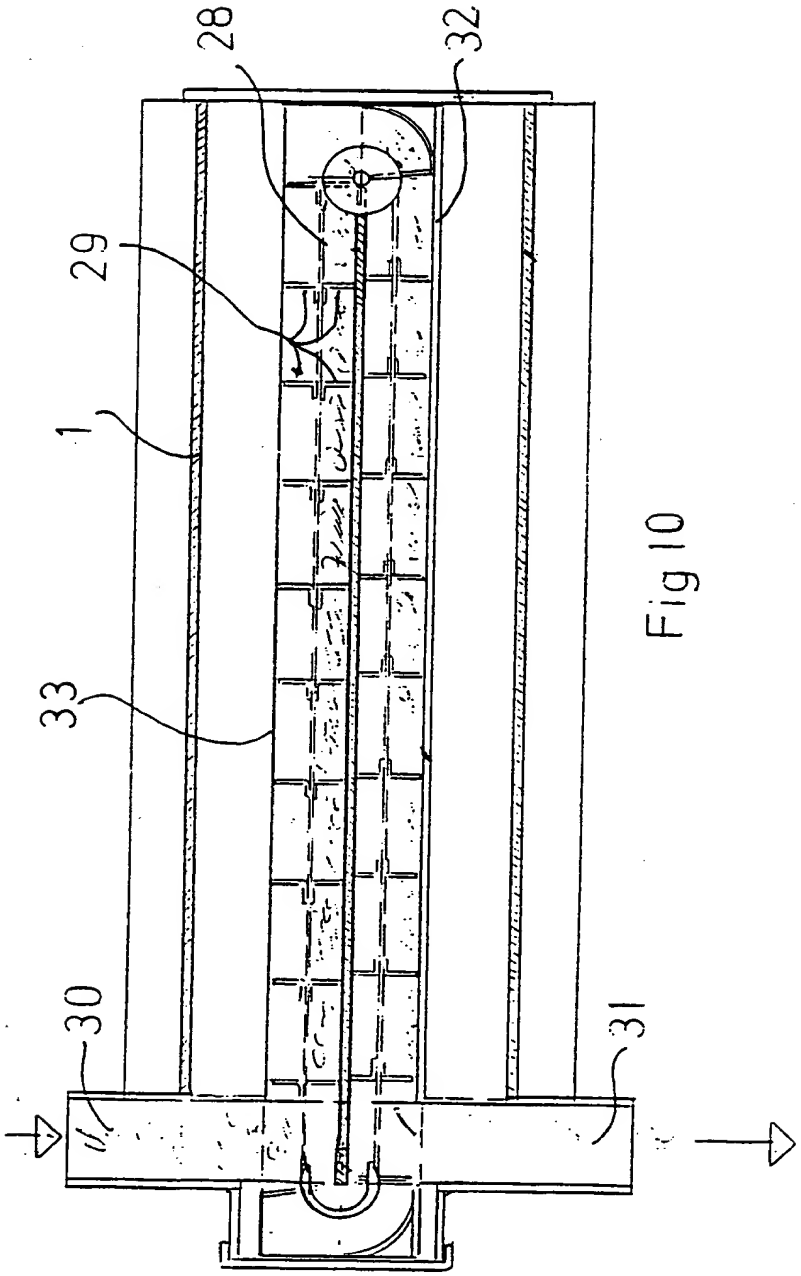

Fig 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00080

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F26B 3/347, F26B 5/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F26B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 19609695 A1 (FZM GESELLSCHAFT FÜR PRODUKTENTWICKLUNG UND EXISTENZGRÜNDUNGFÖREDERUNG GMBH MITTELSACHSEN), 21 August 1997 (21.08.97), column 1, line 37 - line 50, abstract ---	1
X	US 4347670 A (WEAR ET AL.), 7 Sept 1982 (07.09.82), column 3, line 60 - column 4, line 9; column 8, line 15 - line 27; column 11, line 9 - line 21, column 11, line 43 - line 52; figures 2,4-6, abstract ---	1-5
X	US 4330946 A (COURNEYA), 25 May 1982 (25.05.82), column 4, line 56 - column 5, line 37, abstract ---	1,4

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
5 May 1999	07 -05- 1999
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4896434 A (FANELLI), 30 January 1990 (30.01.90), column 1, line 65 - column 2, line 12, figures 1,4, 6, abstract -- --------	1-3

INTERNATIONAL SEARCH REPORT

Int[illegible]ional application No.
PCT/SE 99/00080

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claim No: 6 because it relies on references to the description or drawings. See rule 6.2(a).

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

07/04/99

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19609695 A1	21/08/97	NONE	
US 4347670 A	07/09/82	NONE	
US 4330946 A	25/05/82	AU 7643981 A	14/04/82
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		DK 231582 A	21/05/82
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